DOE Independent Project Review
Critical Decision-3a
Long-Baseline Neutrino Facility/
Deep Underground Neutrino Experiment
(LBNF/DUNE) Project

12/2/2015

Pepin Carolan
Federal Project Director
DOE Fermi Site Office

U.S. DEPARTMENT OF ENERGY
Office of Science

Purpose

- Evaluate Project's readiness for approval of Critical Decision CD-3a, *Approve Initial Far Site Construction*
- Address Far Site Conventional Facilities design, risks, interfaces, logistics– are these sufficiently developed?
- Development of cost, schedule, contingencies and plan for performance tracking– are these credible and adequate to support CD-3a scope?
- Evaluate sufficiency of ES&H aspects and overall effectiveness of the management organization and team

Project Background

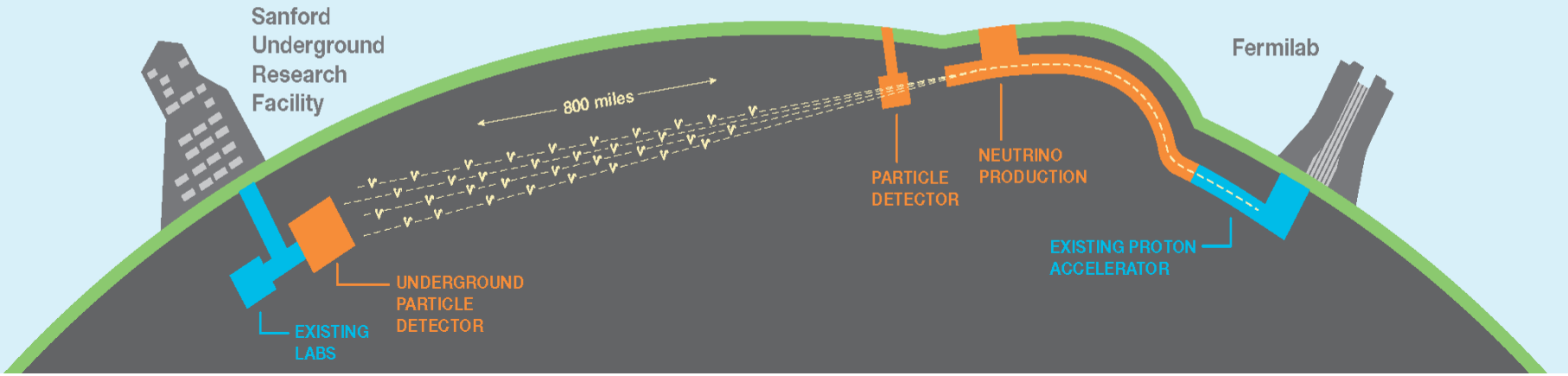
- **May 2014, P5 Recommendations**, *Building for Discovery, Strategic Plan for U.S. Particle Physics in a Global Context:*
  - new international collaboration be formed to design, execute a highly capable Long-Baseline Neutrino Facility (LBNF) hosted by the U.S
  - meet minimum specified requirements in beam power, detector mass and exposure with broader vision→achieve desired sensitivity to Charge-Parity (CP) violation in neutrino oscillations, study of neutrino astrophysics, nucleon decay
- DOE-SC/OHEP requested FNAL to update Project design, cost/schedule, management plans to address P5 recommendations for a larger, more capable facility & detector to support an international collaboration (CD-1 Refresh)
- **CD-1 Refresh approved** Nov. 5, 2015
  - Cost range of $1,260 -$1,860 M
  - Underground siting, larger detector mass, near detector, higher power beamline
  - FNAL to host LBNF/DUNE: first international megascience project on U.S. soil
  - Tailoring Strategy includes CD-3a for initial far site construction prior to CD-2

Project Background

- Updated plan covers full vision of international LBNF/DUNE Project meeting P5 requirements
  - LBNF: A subset of the DOE LBNF/DUNE project that builds the facilities needed for the experiment, with contributions from international partners
  - DUNE: An international project and experiment managed by the DUNE Collaboration, which will provide the detectors following successful LHC model
  - DUNE-US: A subset of the DOE LBNF/DUNE project that includes DOE's contributions to DUNE
- In DOE system, LBNF/DUNE is a single project with two parts: LBNF and DUNE-US (one funding profile, one Program Manager, one FPD)
- Most critical international agreement, with CERN, in place
  - CERN major partner on facility infrastructure, detector prototyping, facilitating European engagement
  - Strong leadership, early support from several countries for DUNE
  - Expect ~3-4 years to complete agreements with individual countries→ informs timeline for LBNF/DUNE CD-2

LBNF/DUNE Scope Overview

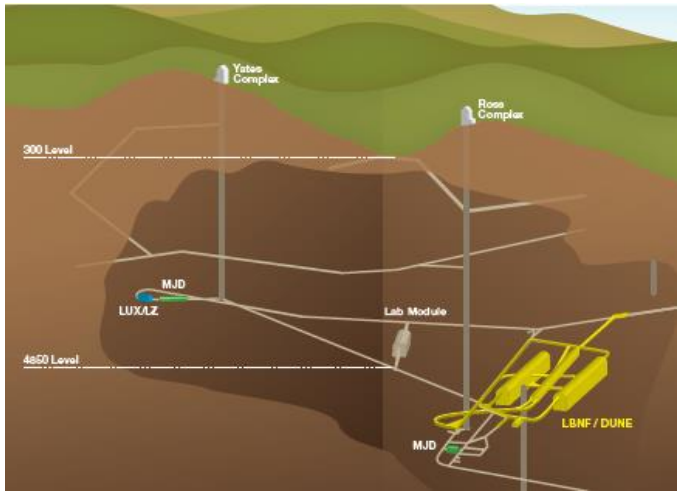
Far Site- SURF in Lead, SD
*Facility/Infrastructure and Far Detector

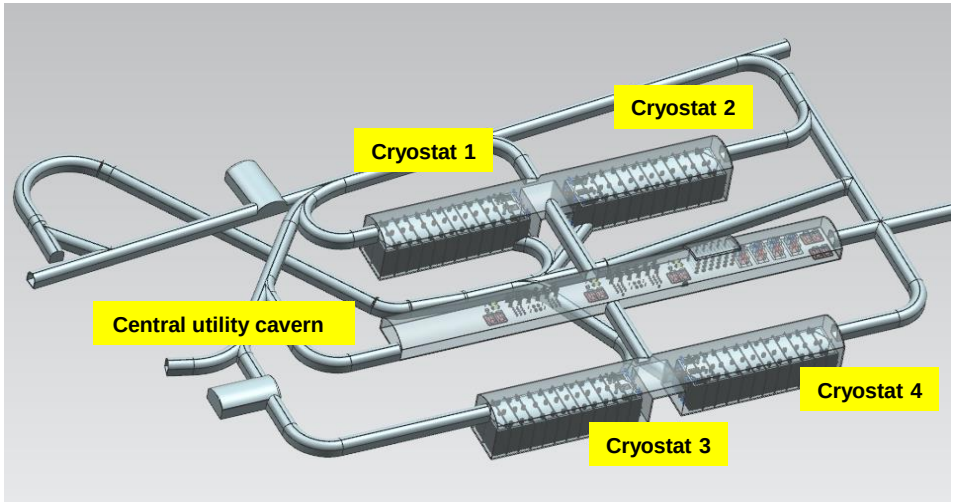


Near Site- Fermilab (FNAL) in Batavia, IL
*Facility/Infrastructure, Neutrino Beamline and Near Detector

U.S. DEPARTMENT OF ENERGY
Office of Science

Project Scope- Far Site



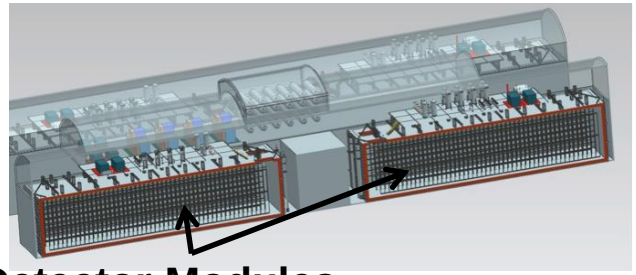


LBNF Far Site Scope:

- Far Site Conventional Facilities Construction: 4850L underground excavation; Infrastructure (Surface/Shaft/4850L); Surface Buildings
- Cryogenic Infrastructure: Cryostats installed in caverns; Utilities/Cryo Support systems (surface and underground) →Includes international contributions

LBNF Enables and Supports DUNE detector:

- Comprised of a detector module installed in each Cryostat
- Up to 40 kiloton mass Liquid Argon Far Detector

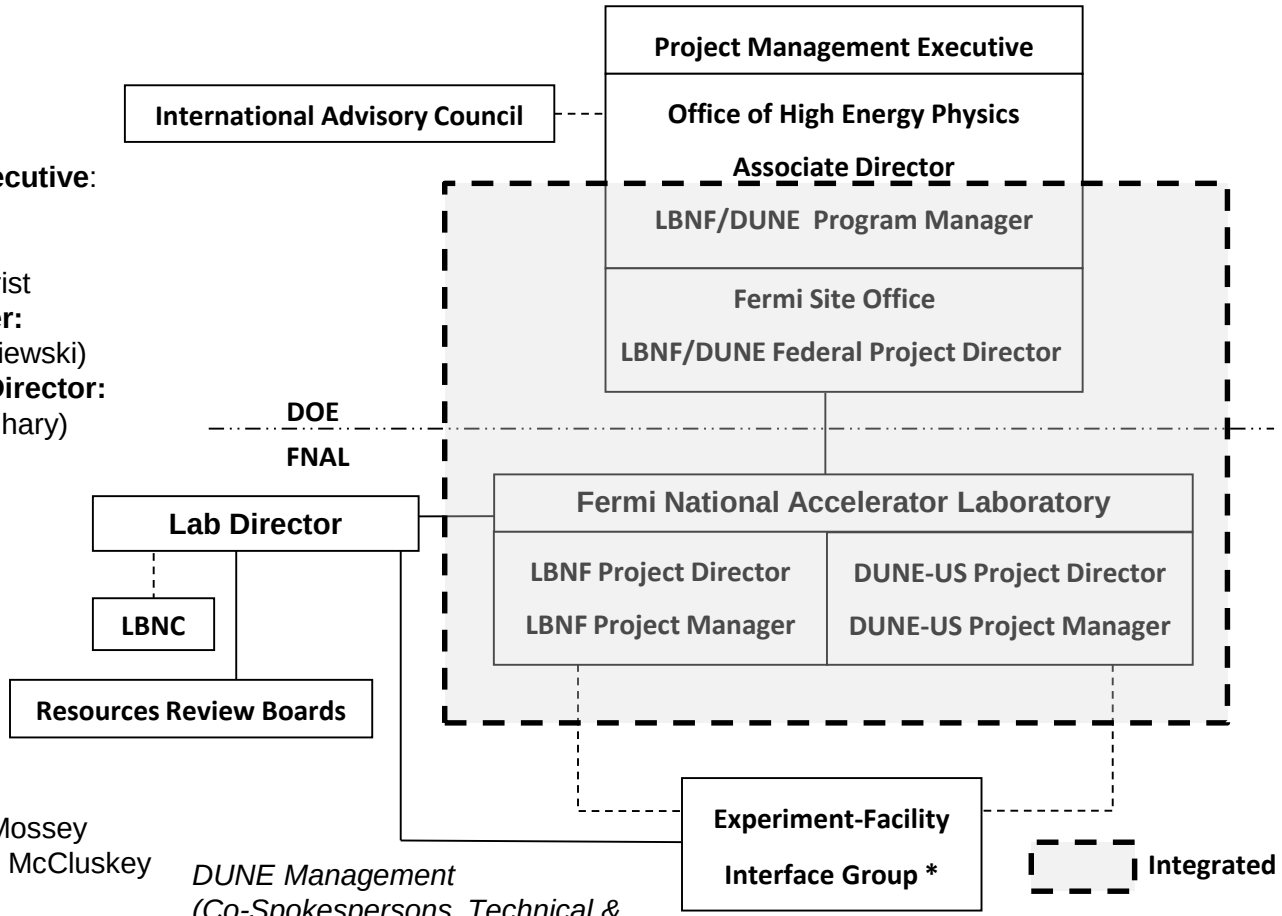


2 of 4 Detector Modules

U.S. DEPARTMENT OF ENERGY
Office of Science

DOE Project Management Organization

DOE Project Management Executive:
Franklin Orr, S-4 (CD-1, 2)
Pat Dehmer, SC-1 (CD-3,4)
AD-OHEP/IAC Chair: Jim Siegrist
LBNF/DUNE Program Manager:
Mike Procario (Deputy Bill Wisniewski)
LBNF/DUNE Federal Project Director:
Pepin Carolan (Deputy Adam Bihary)



FNAL Director: Nigel Lockyer
FNAL Deputy Directors:
Joe Lykken & Chris Mossey
LBNF Project Director: Chris Mossey
LBNF Project Manager: Elaine McCluskey
DUNE Technical Coordinator/
DUNE-US Project Director: Eric James
DUNE-US Project Manager: Jolie Macier

DUNE Management (Co-Spokespersons, Technical & Resource Coordinators) manages International DUNE Project with FNAL (Host Lab) Oversight

**DOE FPD serves as ex-officio EFIG member*

U.S. DEPARTMENT OF ENERGY
Office of Science

DOE Cost and Funding Profile

LBNF/DUNE WBS Title	DOE Total $K
LBNF Project	
Project Office	76,122
Far Site Facilities	438,441
Near Site Facilities	387,729
LBNF Direct TEC + OPC Subtotal	902,292
LBNF DOE Contingency	298,599
LBNF DOE Project Cost Subtotal	1,200,891
DUNE-US Project	
Project Office	28,067
Far Detector	70,121
Near Detector	6,126
DUNE-US Direct TEC + OPC Subtotal	104,314
DUNE-US DOE Contingency	44,157
DUNE-US Project Cost Subtotal	148,471
LBNF/DUNE Conceptual Design	107,638
Total DOE Contingency	342,756
LBNF/DUNE DOE Total Project Cost (TPC)	**1,457,000**

- **DOE TPC: $1,457M**
- **$1,260-$1,860 M range**
- **34% Contingency on DOE costs to go**

- **Total Contribution to LBNF/DUNE includes:**
  - DOE TPC + Non-DOE partner contribution (estimated in international "CORE" accounting)

Fiscal Year	Prior Yrs	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	Total
TEC	24	12	16	70	110	150	180	180	178	180	160	79	20	1359
OPC	76	10	4						2			3	3	98
TPC	**100**	**22**	**20**	**70**	**110**	**150**	**180**	**180**	**180**	**180**	**160**	**82**	**23**	**1457**

U.S. DEPARTMENT OF ENERGY
Office of Science

Critical Decision Schedule

Critical Decision Milestone		Schedule
CD-0	**Approve Mission Need**	1/8/2010 (Actual)
CD-1	**Approve Alternative Selection and Cost Range**	12/10/2012 (Actual)
CD-1	**Approve Alternative Selection and Cost Range (Refresh)**	11/5/2015 (Actual)
CD-3a	**Approve Initial LBNF Far Site Construction**	2nd Quarter, FY2016
CD-3b	**Approve LBNF Near Site Preparation/Far Site Long Lead Procurement**	2nd Quarter, FY2019
CD-2	**Approve Performance Baseline**	1st Quarter, FY2020
CD-3c	**Approve Start of Construction: Remaining LBNF FS, DUNE, LBNF NS**	1st Quarter, FY2020
CD-4	**Approve Project Completion**	4th Quarter, FY2030

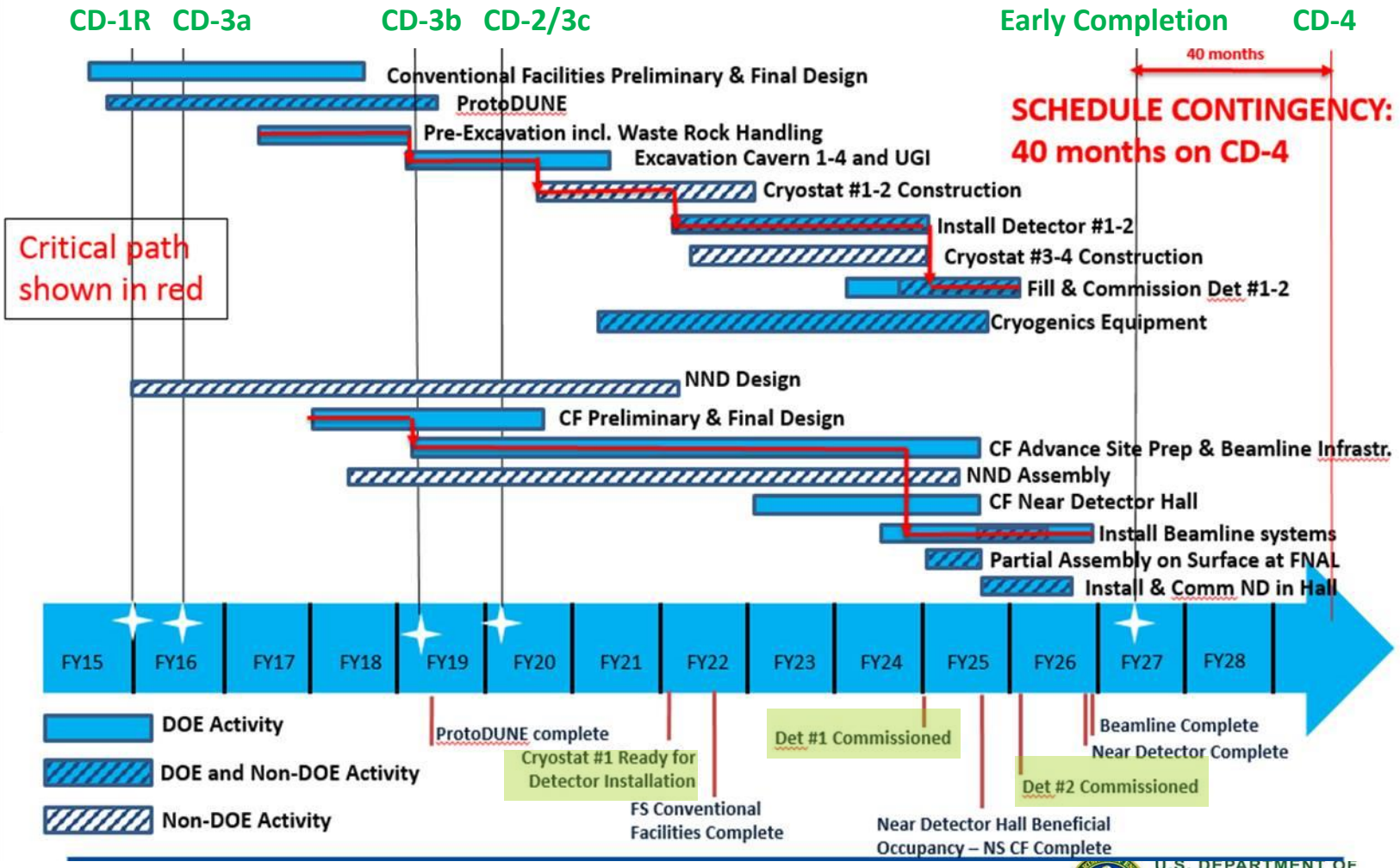
- 40 months float to CD-4 (30% of remaining duration)
- Far Site critical path defined by early science goals and is an important driver of the Tailoring Strategy

Cavern Excavation ⇨ **Cryogenics Infrastructure** ⇨ **Detector Install** ⇨ **Detector Fill & Commission**

- CD-3a authorizes initiation of critical path Far Site cavern excavation activities, prior to CD-2

U.S. DEPARTMENT OF ENERGY
Office of Science

LBNF/DUNE Summary Schedule



U.S. DEPARTMENT OF ENERGY
Office of Science

Critical Decision-3a

CD-3a: Initiates critical path far site cavern excavation activities: initial construction work required, prior to baselining the LBNF/DUNE Project, to support installation of cryostats and cryogenic systems needed to start installation of two DUNE detectors, starting late 2021

- Scope: pre-excavation, excavation (2 chambers+central utility), building/site infrastructure
  Cost: $219M base + $83M contingency= $302M
- If CD-3a scope started as soon as possible:
  - Mitigates risks and minimizes delay in providing a facility ready to accept detectors for installation
  - Advances start and completion of first 2 DUNE 10kt detector modules, to meet the science needs of global neutrino community
  - Reduces project cost due to extended management, escalation, etc.

CD-2/3c: Baseline, construction start for balance (remaining LBNF Far Site, DUNE, LBNF Near Site): ~three-four year timeframe needed after CD-3a for DUNE to incorporate detector development and prototyping into design and to develop fabrication/installation plans aligned with international agreements

CD-3a as planned prior to CD-2 is intended to spur international investment and ensure Facility will be ready for Detector by earliest possible date

Status

- Strong and well integrated project team in place
  - Highly experienced, knowledgeable individuals from management to support staff
  - LBNF-DUNE interfaces are tightly managed, maintained under configuration control; Experiment Facility Interface Group effective
  - FNAL/SURF partnership is solid, with well coordinated Far Site management
  - Suite of Project Management systems and tools in place and being used
- Readiness for CD-3a:
  - Facility requirements and scope understood and controlled; interfaces defined, reviewed and managed; design well advanced and managed
  - Risks identified, understood and managed→ sound process in place
  - ES&H analysis and management plans in place and fully integrated
  - Procurement plans and actions progressing well (LBNF FS CM/GC RFP)
  - Costs, schedule and contingency well-developed and independently reviewed
  - EVM implementation plan in place
  - Director's CD-3a review completed and recommendations addressed
- FNAL providing strong support, oversight; LBNC is active, constructive

Challenges

- **Organizational and management complexity**: international participation, multiple stakeholders and partners (SURF, CERN, DUNE collaboration) → reaching CD-3a readiness a strong test, need to sustain team over long haul
- **Risk Management**: maintaining realism in assessing, updating risks
- **Managing final design for CD-3a scope**: work with cryo and detector on open items; work with A/E and incorporate Construction Manager (CM) into process→ plan and mechanisms in place
- **Logistics planning and execution at SURF:** Many players and parallel activities→ off to good start, getting CM on early helps
- **Procurement Management**: wide range of procurement actions and strategies needed; must meet quality, schedule needs→ experienced manager on board--works closely with DOE; has FNAL/staff support and staffing plan
- **ES&H Management:** clear responsibilities, flow-down and understanding of requirements, hazard analysis and work controls, management and oversight
- **Budget and funding:** continuing resolutions and out-years→ SC/Program working to meet request; early CD-3a retires risk, reduces escalation costs

CD-3 Requirements for CD-3a Scope

CD-3--APPROVE START OF CONSTRUCTION		SC-1	Completed for CD-3a	
PRIOR TO CD-3	Approve Updated CD-2 Project Dcuementation if major changes	Reviewed by SC-28 Approved by SC-1	drafted PPEP update; AS update not required	✓
	Complete Final Design	Project	Final Design Plan	✓
	Incorporate High Perf./Sustainability Requirements	Project	Incorproated	✓
	Conduct a Final Design Review	Team external to project	Preliminary Design Review + Final Design Plan	✓
	Complete a Final Design Report	Project	Preliminary Design Rport + Final Design Plan	✓
	Employ certified EVMS	Certified by SC-28	FNAL EVMS + LBNF EVM Implementation Plan	✓
	Execute Readiness Review	ICE by PMOA	ICE in Process	✓
	Update the Hazard Analysis Report	Site Office or Lab	Updated	✓
	Prepare Construction Project Safety and Health Plan	Site Office or Lab	Prepared for LBNF work at SURF	✓
	Issue Final NEPA Determination	SC-1 or Site Office	FONSI Issued	✓
	Update the Quality Assurance Program (QAP)	Site Office or Lab	Updated	✓
	Finalize the Security Vulnerability Assessment Report, if necessary	Site Office or Lab	Finalized	✓

LBNF/DUNE Project is Prepared for CD-3a